NTC thermistors for temperature measurement

Glass-encapsulated sensors with insulation

Series/Type: **B57541G1**

Date: April 2013

© EPCOS AG 2013. Reproduction, publication and dissemination of this publication, enclosures hereto and the information contained therein without EPCOS' prior express consent is prohibited.

Applications

- Temperature measurement

Features

- Glass-encapsulated NTC thermistor, heat-resistant and highly stable
- Coating of glass body and leads for electrical insulation
- For temperature measurement up to 250 °C
- Very short response time
- Small dimensions
- Leads: dumet wires (copper-clad FeNi)

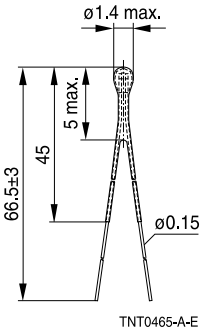
Options

- Alternative dimensions available on request

Delivery mode

Bulk

Dimensional drawing



Dimensions in mm
Approx. weight 40 mg

General technical data

Climatic category	(IEC 60068-1)		55/250/56	
Max. power	(at 25 °C)	P_{25}	18	mW
Resistance tolerance		$\Delta R_R/R_R$	±1, ±2, ±3	%
Rated temperature		T_R	25	°C
Dissipation factor	(in air)	δ_{th}	approx. 0.5	mW/K
Thermal cooling time constant	(in air)	τ_c	approx. 4	s
Heat capacity		C_{th}	approx. 2	mJ/K
Insulation resistance[1)]	(V = 100 V DC)	R_{ins}	≥ 100	MΩ
Test voltage[1)]	(t = 1 s)	V_{test}	500	V DC

1) Medium: NaCl-solution; Temperature: Room temperature

Electrical specification and ordering codes

R_{25} Ω	No. of R/T characteristic	$B_{25/85}$ K	$B_{0/100}$ K	$B_{25/100}$ K	Ordering code
5 k	8324	3483	3456	3497 ±1%	B57541G1502+000
10 k	8307	3478	3450	3492 ±1%	B57541G1103+000
10 k	7003	3612	3586	3625 ±1%	B57541G1103+005
50 k	7002	3973	3944	3988 ±1%	B57541G1503+005
100 k	8304	4072	4036	4092 ±1%	B57541G1104+000

+ = Resistance tolerance
F = ±1%
G = ±2%
H = ±3%

Reliability data

Test	Standard	Test conditions	$\Delta R_{25}/R_{25}$ (typical)	Remarks
Storage in dry heat	IEC 60068-2-2	Storage at upper category temperature T: 250 °C t: 1000 h	< 3%	No visible damage
Storage in damp heat, steady state	IEC 60068-2-67	Temperature of air: 85 °C Relative humidity of air: 85% Duration: 1000 h	< 2%	No visible damage
Rapid temperature cycling	IEC 60068-2-14	Lower test temperature: −55 °C Upper test temperature: 200 °C Number of cycles: 1000	< 2%	No visible damage

Reliability data according to AEC Q200, Rev. D

Test	Standard	Test conditions	$\Delta R_{25}/R_{25}$ (typical)	Remarks
High temperature exposure (storage)	MIL-STD-202, method 108	Storage at T = +125 °C t = 1000 h	< 2%	No visible damage
Operational life	MIL-STD-202, method 108	1000 h / +125 °C Test voltage max. 0.3 V DC on NTC[1)]	< 2%	No visible damage
Temperature cycling	JESD 22, method JA-104	Lower test temperature: −55 °C Upper test temperature: 125 °C 1000 cycles Dwell time: max. 30 min at each temperature Transition time in air: max. 1 min	< 2%	No visible damage
Terminal strength (leaded)	MIL-STD-202, method 211	Test leaded device integrity Condition A: 2.27 N[2)]	< 1%	No visible damage
Mechanical shock	MIL-STD-202, method 213, condition C	Acceleration: 40 *g*[2)] Pulse duration: 6 ms Number of bumps: 3, each direction	< 1%	No visible damage
Vibration	MIL-STD-202, method 204	Acceleration: 5 *g* t = 20 min 12 cycles in each of 3 directions Frequency range: 10 to 2000 Hz	< 1%	No visible damage

1) Self heating of the NTC thermistor must not exceed 0.2 K, steady state. Test conditions deviating from AEC Q200, Rev. D.
2) Deviating from AEC Q200, Rev. D.

Note

- Contact of NTC thermistors with any liquids and solvents shall be prevented. It must be ensured that no water enters the NTC thermistors (e.g. through plug terminals).
- Avoid dewing and condensation unless thermistor is specified for these conditions.

R/T characteristics

R/T No.	**7002**		**7003**		**8304**	
T (°C)	$B_{25/100}$ = 3988 K		$B_{25/100}$ = 3625 K		$B_{25/100}$ = 4092 K	
	R_T/R_{25}	α (%/K)	R_T/R_{25}	α (%/K)	R_T/R_{25}	α (%/K)
−55.0	96.33	7.4	63.225	6.7	100.11	7.4
−50.0	66.866	7.2	45.46	6.5	69.56	7.2
−45.0	47.037	6.9	33.07	6.3	48.945	6.9
−40.0	33.508	6.7	24.324	6.0	34.853	6.7
−35.0	24.156	6.4	18.081	5.8	25.102	6.5
−30.0	17.613	6.2	13.575	5.6	18.275	6.2
−25.0	12.98	6.0	10.29	5.4	13.443	6.0
−20.0	9.6643	5.8	7.8716	5.3	9.9853	5.9
−15.0	7.2656	5.6	6.0739	5.1	7.4867	5.7
−10.0	5.5129	5.4	4.7258	4.9	5.6636	5.5
−5.0	4.22	5.3	3.7062	4.8	4.3212	5.3
0.0	3.2575	5.1	2.9287	4.6	3.324	5.2
5.0	2.5348	4.9	2.3311	4.5	2.5769	5.0
10.0	1.9876	4.8	1.8684	4.4	2.0127	4.9
15.0	1.5699	4.6	1.5075	4.2	1.5834	4.7
20.0	1.2488	4.5	1.224	4.1	1.2542	4.6
25.0	1.0000	4.4	1.0000	4.0	1.0000	4.5
30.0	0.80594	4.3	0.82176	3.9	0.80239	4.3
35.0	0.65355	4.1	0.67909	3.8	0.64776	4.2
40.0	0.53312	4.0	0.56422	3.7	0.52598	4.1
45.0	0.43735	3.9	0.47122	3.6	0.4295	4.0
50.0	0.36074	3.8	0.3955	3.5	0.35262	3.9
55.0	0.29911	3.7	0.33355	3.4	0.291	3.8
60.0	0.24925	3.6	0.2826	3.3	0.24136	3.7
65.0	0.20872	3.5	0.24049	3.2	0.20114	3.6
70.0	0.17558	3.4	0.20553	3.1	0.16841	3.5
75.0	0.14837	3.3	0.17637	3.0	0.14164	3.4
80.0	0.12592	3.2	0.15195	2.9	0.11963	3.3
85.0	0.10731	3.2	0.13141	2.9	0.10147	3.3
90.0	0.091816	3.1	0.11406	2.8	0.086407	3.2
95.0	0.078862	3.0	0.099352	2.7	0.073867	3.1
100.0	0.067988	2.9	0.086837	2.7	0.063383	3.0
105.0	0.058824	2.9	0.076149	2.6	0.054584	3.0
110.0	0.051071	2.8	0.066989	2.5	0.04717	2.9
115.0	0.044489	2.7	0.059112	2.5	0.040901	2.8
120.0	0.03888	2.7	0.052316	2.4	0.035581	2.8
125.0	0.034084	2.6	0.046433	2.4	0.03105	2.7
130.0	0.02997	2.5	0.041327	2.3	0.027179	2.6
135.0	0.02643	2.5	0.03688	2.3	0.023861	2.6
140.0	0.023373	2.4	0.032998	2.2	0.021008	2.5
145.0	0.020727	2.4	0.029598	2.2	0.018548	2.5
150.0	0.018429	2.3	0.026612	2.1	0.016419	2.4
155.0	0.016427	2.3	0.023984	2.1	0.014573	2.4

R/T No.	**7002**		**7003**		**8304**	
T (°C)	$B_{25/100}$ = 3988 K		$B_{25/100}$ = 3625 K		$B_{25/100}$ = 4092 K	
	R_T/R_{25}	α (%/K)	R_T/R_{25}	α (%/K)	R_T/R_{25}	α (%/K)
160.0	0.014679	2.2	0.021665	2.0	0.012967	2.3
165.0	0.013149	2.2	0.019613	2.0	0.011566	2.3
170.0	0.011806	2.1	0.017793	1.9	0.010341	2.2
175.0	0.010623	2.1	0.016176	1.9	0.0092664	2.2
180.0	0.0095804	2.0	0.014735	1.8	0.0083224	2.1
185.0	0.0086582	2.0	0.013448	1.8	0.0074907	2.1
190.0	0.0078408	2.0	0.012297	1.8	0.0067564	2.0
195.0	0.0071148	1.9	0.011265	1.7	0.0061064	2.0
200.0	0.0064685	1.9	0.010338	1.7	0.0055299	2.0
205.0	0.005892	1.8	0.009504	1.7	0.0050175	1.9
210.0	0.0053767	1.8	0.0087516	1.6	0.0045611	1.9
215.0	0.0049152	1.8	0.0080718	1.6	0.0041537	1.9
220.0	0.0045011	1.7	0.0074567	1.6	0.0037895	1.8
225.0	0.0041287	1.7	0.0068989	1.5	0.0034631	1.8
230.0	0.0037934	1.7	0.0063925	1.5	0.0031701	1.8
235.0	0.0034908	1.6	0.0059318	1.5	0.0029067	1.7
240.0	0.0032173	1.6	0.005512	1.5	0.0026693	1.7
245.0	0.0029697	1.6	0.005129	1.4	0.0024551	1.7
250.0	0.0027451	1.6	0.004779	1.4	0.0022615	1.6
255.0	0.0025412	1.5	0.0044586	1.4	0.0020862	1.6
260.0	0.0023556	1.5	0.004165	1.4	0.0019273	1.6
265.0	0.0021865	1.5	0.0038955	1.3	0.0017829	1.5
270.0	0.0020323	1.5	0.0036478	1.3	0.0016516	1.5
275.0	0.0018913	1.4	0.0034199	1.3	0.0015319	1.5
280.0	0.0017623	1.4	0.0032098	1.3	0.0014228	1.5
285.0	0.0016441	1.4	0.003016	1.2	0.0013231	1.4
290.0	0.0015357	1.4	0.002837	1.2	0.0012319	1.4
295.0	0.001436	1.3	0.0026714	1.2	0.0011483	1.4
300.0	0.0013444	1.3	0.002518	1.2	0.0010716	1.4

R/T characteristics

R/T No.	8307		8324	
T (°C)	$B_{25/100}$ = 3492 K		$B_{25/100}$ = 3497 K	
	R_T/R_{25}	α (%/K)	R_T/R_{25}	α (%/K)
−55.0	52.624	6.4	53.720	6.5
−50.0	38.452	6.2	39.080	6.2
−45.0	28.401	6.0	28.768	6.0
−40.0	21.194	5.8	21.412	5.8
−35.0	15.972	5.6	16.104	5.6
−30.0	12.149	5.4	12.231	5.4
−25.0	9.3246	5.2	9.3758	5.2
−20.0	7.2181	5.0	7.2507	5.1
−15.0	5.6332	4.9	5.6542	4.9
−10.0	4.4308	4.7	4.4444	4.7
−5.0	3.5112	4.6	3.5200	4.6
0.0	2.8024	4.4	2.8080	4.5
5.0	2.252	4.3	2.2555	4.3
10.0	1.8216	4.2	1.8236	4.2
15.0	1.4827	4.1	1.4838	4.1
20.0	1.2142	3.9	1.2146	3.9
25.0	1.0000	3.8	1.0000	3.8
30.0	0.82818	3.7	0.82789	3.7
35.0	0.68954	3.6	0.68906	3.6
40.0	0.57703	3.5	0.57644	3.5
45.0	0.48525	3.4	0.48461	3.4
50.0	0.41	3.3	0.40933	3.3
55.0	0.34798	3.2	0.34732	3.2
60.0	0.29663	3.2	0.29599	3.2
65.0	0.25392	3.1	0.25331	3.1
70.0	0.21824	3.0	0.21767	3.0
75.0	0.1883	2.9	0.18777	2.9
80.0	0.16307	2.8	0.16259	2.8
85.0	0.14174	2.8	0.14130	2.8
90.0	0.12362	2.7	0.12323	2.7
95.0	0.10818	2.6	0.10783	2.6
100.0	0.094973	2.6	0.094663	2.6
105.0	0.08364	2.5	0.083368	2.5
110.0	0.073881	2.5	0.073645	2.5
115.0	0.06545	2.4	0.065247	2.4
120.0	0.058144	2.3	0.057972	2.3
125.0	0.051794	2.3	0.051649	2.3
130.0	0.046259	2.2	0.046139	2.2
135.0	0.04142	2.2	0.041323	2.2
140.0	0.037179	2.1	0.037102	2.1
145.0	0.033451	2.1	0.033393	2.1
150.0	0.030166	2.0	0.030125	2.0
155.0	0.027264	2.0	0.027238	2.0

R/T No.	**8307**		**8324**	
T (°C)	$B_{25/100}$ = 3492 K		$B_{25/100}$ = 3497 K	
	R_T/R_{25}	α (%/K)	R_T/R_{25}	α (%/K)
160.0	0.024694	2.0	0.024669	1.9
165.0	0.022414	1.9	0.022398	1.9
170.0	0.020385	1.9	0.020383	1.9
175.0	0.018577	1.8	0.018589	1.8
180.0	0.016961	1.8	0.016987	1.8
185.0	0.015514	1.8	0.015552	1.7
190.0	0.014216	1.7	0.014263	1.7
195.0	0.013049	1.7	0.013104	1.7
200.0	0.011999	1.7	0.012060	1.6
205.0	0.011051	1.6	0.011117	1.6
210.0	0.010194	1.6	0.010264	1.6
215.0	0.0094181	1.6	0.0094930	1.5
220.0	0.0087144	1.5	0.0087939	1.5
225.0	0.0080751	1.5	0.0081599	1.5
230.0	0.0074933	1.5	0.0075842	1.4
235.0	0.0069631	1.5	0.0070611	1.4
240.0	0.0064791	1.4	0.0065853	1.4
245.0	0.0060366	1.4	0.0061522	1.3
250.0	0.0056316	1.4	0.0057577	1.3
255.0	0.0052602	1.4	–	–
260.0	0.0049193	1.3	–	–
265.0	0.0046059	1.3	–	–
270.0	0.0043173	1.3	–	–
275.0	0.0040514	1.3	–	–
280.0	0.003806	1.2	–	–
285.0	0.0035793	1.2	–	–
290.0	0.0033696	1.2	–	–
295.0	0.0031753	1.2	–	–
300.0	0.0029952	1.2	–	–

Mounting instructions

1 Soldering

1.1 Leaded NTC thermistors

Leaded thermistors comply with the solderability requirements specified by CECC.

When soldering, care must be taken that the NTC thermistors are not damaged by excessive heat. The following maximum temperatures, maximum time spans and minimum distances have to be observed:

	Dip soldering	*Iron soldering*
Bath temperature	max. 260 °C	max. 360 °C
Soldering time	max. 4 s	max. 2 s
Distance from thermistor	min. 6 mm	min. 6 mm

Under more severe soldering conditions the resistance may change.

1.2 Leadless NTC thermistors

In case of NTC thermistors without leads, soldering is restricted to devices which are provided with a solderable metallization. The temperature shock caused by the application of hot solder may produce fine cracks in the ceramic, resulting in changes in resistance.

To prevent leaching of the metallization, solder with silver additives or with a low tin content should be used. In addition, soldering methods should be employed which permit short soldering times.

1.3 SMD NTC thermistors

SMD NTC thermistors can be provided with a nickel barrier termination or on special request with silver-palladium termination. The usage of mild, non-activated fluxes for soldering is recommended as well as a proper cleaning of the PCB.

- Nickel barrier termination

The nickel barrier layer of the silver/nickel/tin termination (see figure 1) prevents leaching of the silver base metalization layer. This allows great flexibility in the selection of soldering parameters.

The tin prevents the nickel layer from oxidizing and thus ensures better wetting by the solder. The nickel barrier termination is suitable for all commonly-used soldering methods.

Note: SMD NTCs with AgPd termination are not approved for lead-free soldering.

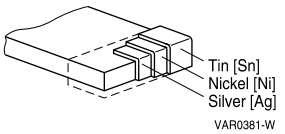


Figure 1

SMD NTC thermistors, structure of nickel barrier termination

1.3.1 Solderability (test to IEC 60068-2-58)

Preconditioning: Immersion into flux F-SW 32.
Evaluation criterion: Wetting of soldering areas ≥95%.

Solder	Bath temperature (°C)	Dwell time (s)
SnPb 60/40	215 ±3	3 ±0.3
SnAg (3.0 ... 4.0), Cu (0.5 ... 0.9)	245 ±3	3 ±0.3

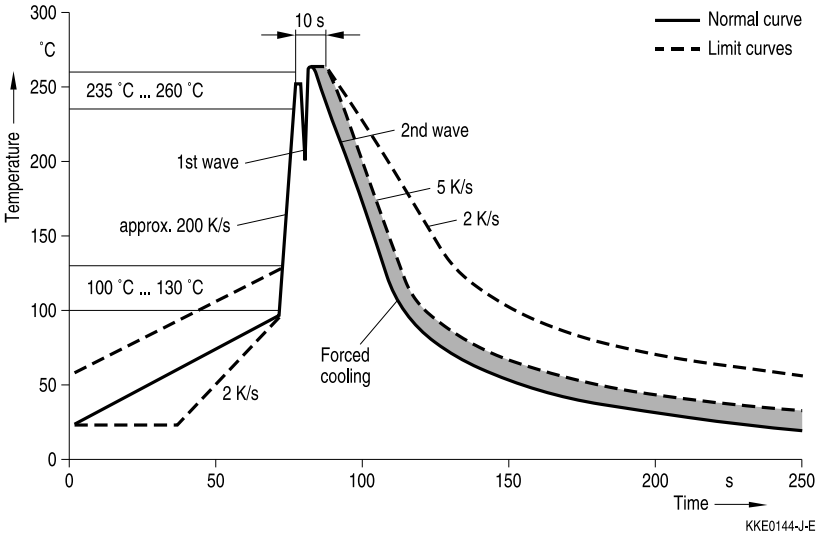
1.3.2 Resistance to soldering heat (test to IEC 60068-2-58)

Preconditioning: Immersion into flux F-SW 32.
Evaluation criterion: Leaching of side edges ≤1/3.

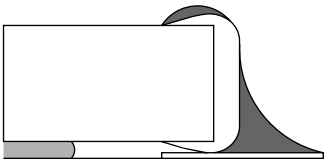
Solder	Bath temperature (°C)	Dwell time (s)
SnPb 60/40	260 ±5	10 ±1
SnAg (3.0 ... 4.0), Cu (0.5 ... 0.9)	260 ±5	10 ±1

Wave soldering

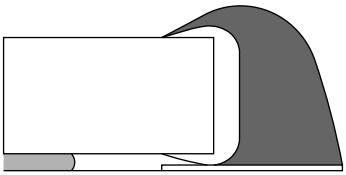
Temperature characteristic at component terminal with dual wave soldering



Solder joint profiles for silver/nickel/tin terminations



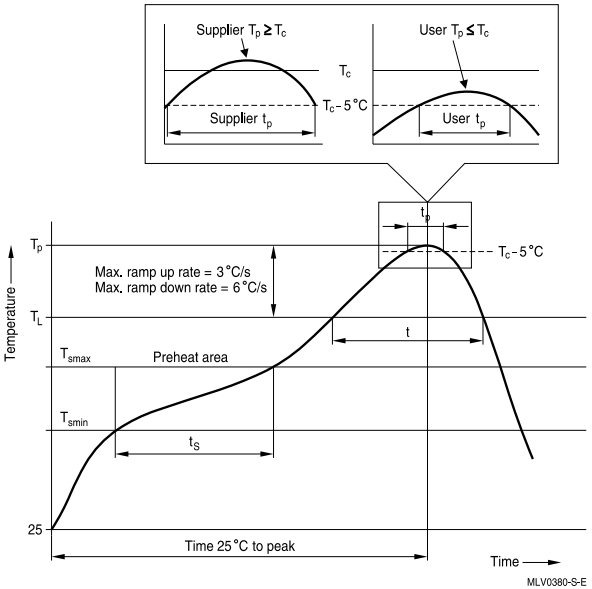
Good solder joint KKE0287-9-E



Too much solder
Pad geometry too large,
not soldered in preferred direction KKE0288-H-E

Reflow soldering

Recommended temperature characteristic for reflow soldering following JEDEC J-STD-020D

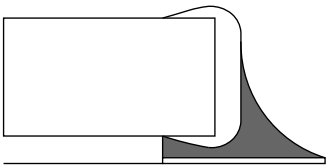


Profile feature		Sn-Pb eutectic assembly	Pb-free assembly
Preheat and soak			
- Temperature min	T_{smin}	100 °C	150 °C
- Temperature max	T_{smax}	150 °C	200 °C
- Time	t_{smin} to t_{smax}	60 ... 120 s	60 ... 180 s
Average ramp-up rate	T_{smax} to T_p	3 °C/ s max.	3 °C/ s max.
Liquidous temperature	T_L	183 °C	217 °C
Time at liquidous	t_L	60 ... 150 s	60 ... 150 s
Peak package body temperature	T_p [1)]	220 °C ... 235 °C [2)]	245 °C ... 260 °C [2)]
Time (t_P) [3)] within 5 °C of specified classification temperature (T_c)		20 s [3)]	30 s [3)]
Average ramp-down rate	T_p to T_{smax}	6 °C/ s max.	6 °C/ s max.
Time 25 °C to peak temperature		maximum 6 min	maximum 8 min

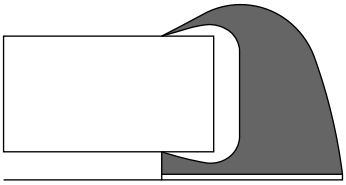
1) Tolerance for peak profile temperature (T_P) is defined as a supplier minimum and a user maximum.
2) Depending on package thickness. For details please refer to JEDEC J-STD-020D.
3) Tolerance for time at peak profile temperature (t_P) is defined as a supplier minimum and a user maximum.

Note: All temperatures refer to topside of the package, measured on the package body surface. Number of reflow cycles: 3

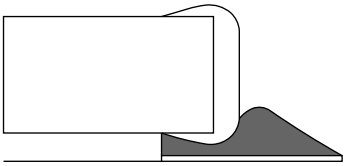
Solder joint profiles for silver/nickel/tin terminations



Good solder joint TNT0565-G-E

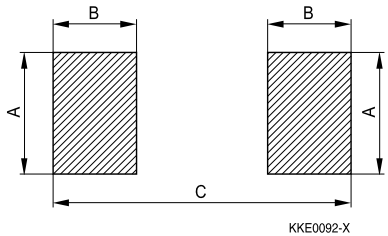


Too much solder
Pad geometry too large KKE0071-A-E



Poor wetting KKE0072-I-E

1.3.3 Recommended geometry of solder pads



KKE0092-X

Recommended maximum dimensions (mm)

Case size inch/mm	A	B	C
0402/1005	0.6	0.6	1.7
0603/1608	1.0	1.0	3.0
0805/2012	1.3	1.2	3.4
1206/3216	1.8	1.2	4.5

1.3.4 Notes

Iron soldering should be avoided, hot air methods are recommended for repair purposes.

2 Conductive adhesion

An alternative to soldering is the gluing of thermistors with conductive adhesives. The benefit of this method is that it involves no thermal stress. The adhesives used must be chemically inert.

3 Clamp contacting

Pressure contacting by means of clamps is particularly suitable for applications involving frequent switching and high turn-on powers.

4 Robustness of terminations (leaded types)

The leads meet the requirements of IEC 60068-2-21. They may not be bent closer than 4 mm from the solder joint on the thermistor body or from the point at which they leave the feed-throughs. During bending, any mechanical stress at the outlet of the leads must be removed. The bending radius should be at least 0.75 mm.

Tensile strength: Test Ua1:

Leads		
	∅ ≤0.25 mm =	1.0 N
0.25 <	∅ ≤0.35 mm =	2.5 N
0.35 <	∅ ≤0.50 mm =	5.0 N
0.50 <	∅ ≤0.80 mm =	10.0 N
0.80 <	∅ ≤1.25 mm =	20.0 N

Bending strength: Test Ub:

Two 90°-bends in opposite directions at a weight of 0.25 kg.

Torsional strength: Test Uc: severity 2

The lead is bent by 90° at a distance of 6 to 6.5 mm from the thermistor body.

The bending radius of the leads should be approx. 0.75 mm. Two torsions of 180° each (severity 2).

When subjecting leads to mechanical stress, the following should be observed:

Tensile stress on leads

During mounting and operation tensile forces on the leads are to be avoided.

Bending of leads

Bending of the leads directly on the thermistor body is not permissible.

A lead may be bent at a minimum distance of twice the wire's diameter +2 mm from the solder joint on the thermistor body. During bending the wire must be mechanically relieved at its outlet. The bending radius should be at least 0.75 mm.

Twisting of leads

The twisting (torsion) by 180° of a lead bent by 90° is permissible at 6 mm from the bottom of the thermistor body.

5 Sealing and potting

When thermistors are sealed, potted or overmolded, there must be no mechanical stress caused by thermal expansion during the production process (curing / overmolding process) and during later operation. The upper category temperature of the thermistor must not be exceeded. Ensure that the materials used (sealing / potting compound and plastic material) are chemically neutral.

6 Cleaning

Washing processes may damage the product due to the possible static or cyclic mechanical loads (e.g. ultrasonic cleaning). They may cause cracks to develop on the product and its parts, which might lead to reduced reliability or lifetime.

7 Storage

In order to maintain their solderability, thermistors must be stored in a non-corrosive atmosphere. Humidity, temperature and container materials are critical factors.

Do not store SMDs where they are exposed to heat or direct sunlight. Otherwise, the packing material may be deformed or SMDs may stick together, causing problems during mounting. After opening the factory seals, such as polyvinyl-sealed packages, use the SMDs as soon as possible.

The components should be left in the original packing. Touching the metallization of unsoldered thermistors may change their soldering properties.

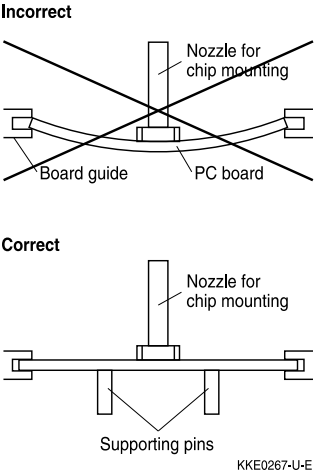
Storage temperature:	−25 °C up to 45 °C
Relative humidity (without condensation):	≤75% annual mean
	<95%, maximum 30 days per annum

Solder the thermistors listed in this data book after shipment from EPCOS within the time specified:

SMDs with nickel barrier termination:	12 months
SMDs with AgPd termination:	6 months
Leaded components:	24 months

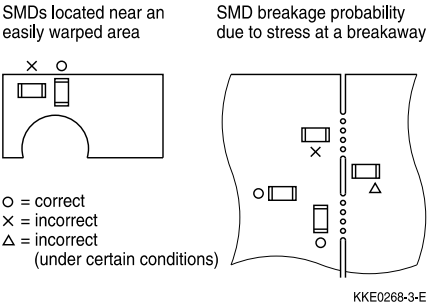
8 Placement and orientation of SMD NTC thermistors on PCB

a) Component placement



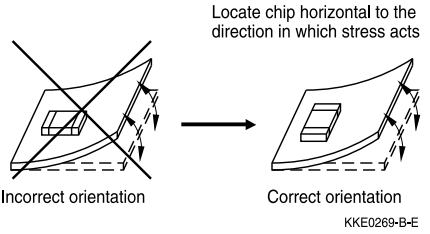
It is recommended that the PC board should be held by means of some adequate supporting pins such as shown left to prevent the SMDs from being damaged or cracked.

b) Cracks



When placing a component near an area which is apt to bend or a grid groove on the PC board, it is advisable to have both electrodes subjected to uniform stress, or to position the component's electrodes at right angles to the grid groove or bending line (see c) Component orientation).

c) Component orientation



Choose a mounting position that minimizes the stress imposed on the chip during flexing or bending of the board.

Cautions and warnings

See "Important notes".

Storage

- Store thermistors only in original packaging. Do not open the package prior to storage.
- Storage conditions in original packaging: storage temperature −25 °C ... +45 °C, relative humidity ≤75% annual mean, <95% maximum 30 days per annum, dew precipitation is inadmissible.
- Do not store thermistors where they are exposed to heat or direct sunlight. Otherwise, the packing material may be deformed or components may stick together, causing problems during mounting.
- Avoid contamination of thermistor surface during storage, handling and processing.
- Avoid storage of thermistors in harmful environments like corrosive gases (SO_x, Cl etc).
- Use the components as soon as possible after opening the factory seals, i.e. the polyvinyl-sealed packages.
- Solder thermistors within the time specified after shipment from EPCOS.
  For leaded components this is 24 months, for SMD components with nickel barrier termination 12 months, for SMD components with AgPd termination 6 months.

Handling

- NTC thermistors must not be dropped. Chip-offs or any other damage must not be caused during handling of NTCs.
- Do not touch components with bare hands. Gloves are recommended.
- Avoid contamination of thermistor surface during handling.
- Washing processes may damage the product due to the possible static or cyclic mechanical loads (e.g. ultrasonic cleaning). They may cause cracks to develop on the product and its parts, which might lead to reduced reliability or lifetime.

Bending / twisting leads

- A lead (wire) may be bent at a minimum distance of twice the wire's diameter plus 4 mm from the component head or housing. When bending ensure the wire is mechanically relieved at the component head or housing. The bending radius should be at least 0.75 mm.
- Twisting (torsion) by 180° of a lead bent by 90° is permissible at 6 mm from the bottom of the thermistor body.

Soldering

- Use resin-type flux or non-activated flux.
- Insufficient preheating may cause ceramic cracks.
- Rapid cooling by dipping in solvent is not recommended.
- Complete removal of flux is recommended.

Mounting

- Ensure that no thermo-mechanical stress occurs due to production processes (curing or overmolding processes) when thermistors are sealed, potted or overmolded or during their subsequent operation. The maximum temperature of the thermistor must not be exceeded. Ensure that the materials used (sealing/potting compound and plastic material) are chemically neutral.
- Electrodes/contacts must not be scratched or damaged before/during/after the mounting process.
- Contacts and housing used for assembly with the thermistor must be clean before mounting.
- Ensure that adjacent materials are designed for operation at temperatures comparable to the surface temperature of the thermistor. Be sure that surrounding parts and materials can withstand the temperature.
- Avoid contamination of the thermistor surface during processing.
- The connections of sensors (e.g. cable end, wire end, plug terminal) may only be exposed to an environment with normal atmospheric conditions.
- Tensile forces on cables or leads must be avoided during mounting and operation.
- Bending or twisting of cables or leads directly on the thermistor body is not permissible.
- Avoid using chemical substances as mounting aids. It must be ensured that no water or other liquids enter the NTC thermistors (e.g. through plug terminals). In particular, water based substances (e.g. soap suds) must not be used as mounting aids for sensors.

Operation

- Use thermistors only within the specified operating temperature range.
- Use thermistors only within the specified power range.
- Environmental conditions must not harm the thermistors. Only use the thermistors under normal atmospheric conditions or within the specified conditions.
- Contact of NTC thermistors with any liquids and solvents shall be prevented. It must be ensured that no water enters the NTC thermistors (e.g. through plug terminals). For measurement purposes (checking the specified resistance vs. temperature), the component must not be immersed in water but in suitable liquids (e.g. Galden).
- Avoid dewing and condensation unless thermistor is specified for these conditions.
- Bending or twisting of cables and/or wires is not permissible during operation of the sensor in the application.
- Be sure to provide an appropriate fail-safe function to prevent secondary product damage caused by malfunction.

This listing does not claim to be complete, but merely reflects the experience of EPCOS AG.

Symbols and terms

Symbol	English	German
A	Area	Fläche
AWG	American Wire Gauge	Amerikanische Norm für Drahtquerschnitte
B	B value	B-Wert
$B_{25/100}$	B value determined by resistance measurement at 25 °C and 100 °C	B-Wert, ermittelt durch Widerstands-messungen bei 25 °C und 100 °C
C_{th}	Heat capacitance	Wärmekapazität
I	Current	Strom
N	Number (integer)	Anzahl (ganzzahliger Wert)
P_{25}	Maximum power at 25 °C	Maximale Leistung bei 25 °C
P_{diss}	Power dissipation	Verlustleistung
P_{el}	Electrical power	Elektrische Leistung
P_{max}	Maximum power within stated temperature range	Maximale Leistung im angegebenenTemperaturbereich
$\Delta R_B/R_B$	Resistance tolerance caused by spread of B value	Widerstandstoleranz, die durch die Streuung des B-Wertes verursacht wird
R_{ins}	Insulation resistance	Isolationswiderstand
R_P	Parallel resistance	Parallelwiderstand
R_R	Rated resistance	Nennwiderstand
$\Delta R_R/R_R$	Resistance tolerance	Widerstandstoleranz
R_S	Series resistance	Serienwiderstand
R_T	Resistance at temperature T (e.g. R_{25} = resistance at 25 °C)	Widerstand bei Temperatur T (z.B. R_{25} = Widerstand bei 25 °C)
T	Temperature	Temperatur
ΔT	Temperature tolerance	Temperaturtoleranz
t	Time	Zeit
T_A	Ambient temperature	Umgebungstemperatur
T_{max}	Upper category temperature	Obere Grenztemperatur (Kategorietemperatur)
T_{min}	Lower category temperature	Untere Grenztemperatur (Kategorietemperatur)
T_{op}	Operating temperature	Betriebstemperatur
T_R	Rated temperature	Nenntemperatur
T_{surf}	Surface temperature	Oberflächentemperatur
V	Voltage	Spannung
V_{ins}	Insulation test voltage	Isolationsprüfspannung
V_{op}	Operating voltage	Betriebsspannung
V_{test}	Test voltage	Prüfspannung

Symbol	English	German
α	Temperature coefficient	Temperaturkoeffizient
Δ	Tolerance, change	Toleranz, Änderung
δ_{th}	Dissipation factor	Wärmeleitwert
τ_c	Thermal cooling time constant	Thermische Abkühlzeitkonstante
τ_a	Thermal time constant	Thermische Zeitkonstante

Abbreviations / Notes

Symbol	English	German
SMD	Surface-mounted devices	Oberflächenmontierbares Bauelement
*	To be replaced by a number in ordering codes, type designations etc.	Platzhalter für Zahl im Bestellnummern-code oder für die Typenbezeichnung.
+	To be replaced by a letter.	Platzhalter für einen Buchstaben.
	All dimensions are given in mm.	Alle Maße sind in mm angegeben.
	The commas used in numerical values denote decimal points.	Verwendete Kommas in Zahlenwerten bezeichnen Dezimalpunkte.

Important notes

The following applies to all products named in this publication:

1. Some parts of this publication contain **statements about the suitability of our products for certain areas of application**. These statements are based on our knowledge of typical requirements that are often placed on our products in the areas of application concerned. We nevertheless expressly point out **that such statements cannot be regarded as binding statements about the suitability of our products for a particular customer application**. As a rule, EPCOS is either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always ultimately incumbent on the customer to check and decide whether an EPCOS product with the properties described in the product specification is suitable for use in a particular customer application.
2. We also point out that **in individual cases, a malfunction of electronic components or failure before the end of their usual service life cannot be completely ruled out in the current state of the art, even if they are operated as specified**. In customer applications requiring a very high level of operational safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health (e.g. in accident prevention or lifesaving systems), it must therefore be ensured by means of suitable design of the customer application or other action taken by the customer (e.g. installation of protective circuitry or redundancy) that no injury or damage is sustained by third parties in the event of malfunction or failure of an electronic component.
3. **The warnings, cautions and product-specific notes must be observed.**
4. In order to satisfy certain technical requirements, **some of the products described in this publication may contain substances subject to restrictions in certain jurisdictions (e.g. because they are classed as hazardous)**. Useful information on this will be found in our Material Data Sheets on the Internet (www.epcos.com/material). Should you have any more detailed questions, please contact our sales offices.
5. We constantly strive to improve our products. Consequently, **the products described in this publication may change from time to time**. The same is true of the corresponding product specifications. Please check therefore to what extent product descriptions and specifications contained in this publication are still applicable before or when you place an order. We also **reserve the right to discontinue production and delivery of products**. Consequently, we cannot guarantee that all products named in this publication will always be available. The aforementioned does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.
6. Unless otherwise agreed in individual contracts, **all orders are subject to the current version of the "General Terms of Delivery for Products and Services in the Electrical Industry" published by the German Electrical and Electronics Industry Association (ZVEI)**.
7. The trade names EPCOS, BAOKE, Alu-X, CeraDiode, CeraLink, CSMP, CSSP, CTVS, DeltaCap, DigiSiMic, DSSP, FilterCap, FormFit, MiniBlue, MiniCell, MKD, MKK, MLSC, MotorCap, PCC, PhaseCap, PhaseCube, PhaseMod, PhiCap, SIFERRIT, SIFI, SIKOREL, SilverCap, SIMDAD, SiMic, SIMID, SineFormer, SIOV, SIP5D, SIP5K, ThermoFuse, WindCap are **trademarks registered or pending** in Europe and in other countries. Further information will be found on the Internet at www.epcos.com/trademarks.